Series II, Volume 2 March 1, 1957 Number 2

BULLETIN

OF THE

AMERICAN PHYSICAL SOCIETY

PROGRAMME OF THE

1957 SOUTHWESTERN MEETING

AT

THE UNIVERSITY OF OKLAHOMA, NORMAN

March 1 and 2, 1957

PUBLISHED BY THE AMERICAN PHYSICAL SOCIETY, COLUMBIA UNIVERSITY, NEW YORK 27, NEW YORK
EIGHT ISSUES EACH YEAR

BULLETIN

of the

AMERICAN PHYSICAL SOCIETY

Published eight times per year

Subscription price: $5.00 per year

Single copies: $1.00 each

The Bulletin of the American Physical Society is published eight times a year, once in January, twice in March, once in April, once in June, once in September, once in November, and once in December, at Prince and Lemon Streets, Lancaster, Pennsylvania. Correspondence should be addressed to American Physical Society, Columbia University, New York 27, New York.

Entered as second class matter, December 27, 1949, at the post office at Lancaster, Pa., under the Act of August 24, 1912.

Acceptance for mailing at a special rate of postage provided for in paragraph (d-2), Section 34.40, P. L. & R. of 1948, authorized Nov. 30, 1948.

Table of Contents

Programme of the 1957 Southwestern Meeting to be held at Norman, Oklahoma 94
Author Index to the Norman Programme 108
Second Announcement of the 1957 Philadelphia Meeting 109
Preliminary Announcement of the 1957 Spring Meeting 109
Calendar of Future Meetings and Deadlines . . 110
Rules Prescribed for Abstracts 110
Reservation Form for the Norman Banquet . . . 111

March 1, 1957 Series II, Vol. 2, No. 2

BULLETIN

OF THE

AMERICAN PHYSICAL SOCIETY

1957 Southwestern Meeting at Norman, Oklahoma, March 1 and 2, 1957

THE **1957 Southwestern Meeting** of the American Physical Society will be held at Norman, Oklahoma, in the buildings of the University of Oklahoma, on Friday and Saturday, **March first and second,** 1957. This is the fifth in our sequence of meetings in the Southwestern area, or the sixth if we include the Albuquerque meeting of 1953; and it will be the very first meeting ever held by our Society in the state of Oklahoma. The Chairman of the Local Committee is Professor J. Rud Nielsen of the University of Oklahoma.

In Norman, first-class **hotel accommodations** are available at the Lockett Hotel, Norman Courts, and Sooner Courts. In Norman also, the University at its North Campus can provide standard hotel accommodations for sixty persons and inexpensive dormitory-type accommodations for about 270 persons: reservations for these should be made through Professor J. Rud Nielsen, University of Oklahoma, Norman, Oklahoma; write to him promptly. Breakfast will be available at the North Campus; buses will be provided for transportation between North Campus and Main Campus where the meetings are. In Oklahoma City, eighteen miles to the north, are numerous hotels, two among which are the Skirvin Tower and the Biltmore. The driving time between the two cities is about 35 minutes. Regular buses leave every half-hour up to noon, every hour during afternoons and evenings; the University stands ready to provide additional buses if they are needed. Norman is on the Santa Fe line between Chicago and Galveston, and there is an airport available for private planes. Oklahoma City is on lines of the Frisco from St. Louis, of the Santa Fe and Rock Island from the west, and has ample service by air.

The **registration desk** will be located in the lobby of the Oklahoma Memorial Union Building of the University of Oklahoma. A registration fee of one dollar will be requested. Blackboards will be set up in the vicinity of the registration desk to carry notices of messages, post-deadline papers if any, and changes in arrangements if any: they should be consulted frequently.

The **banquet of the Society** will be held on Friday evening in the Ballroom of the Oklahoma Memorial Union. An after-dinner speech will be delivered by Laurence H. Snyder, Dean of the Graduate College of the University and presently President of the American Association for the Advancement of Science. Tickets at $3.00 will be available at the registration desk until 3 P.M. on Friday. It will be advantageous if those of our members and guests who are reasonably sure of attending will use the reservation form on page 111 of this Bulletin.

Luncheons will be served at $1.25 in the Union Ball Room at 12:15 P.M. on Friday and Saturday, and there will be no standing in line for those who buy their tickets for these before 10:30 A.M. at the registration desk.

Oklahoma is a dry State, but **coffee** will be available at most times during the meeting, by courtesy of the University.

The attention of our members and guests is drawn to the **DeGolyer Collection on the History of Science,** the curator of which is our fellow-physicist, Duane H. D. Roller. It consists of more than 12 000 volumes of source material on the history of science, including original editions of Galileo and many other pioneers of science: a selection of these will be shown in the lobbies of the Library and the Physics Building of the University, and visits to the collection are encouraged.

Invited papers in our programme have been drawn mainly but not wholly from the Southwestern area, and in accordance with our usual practice at these meetings they have been bespoken to range widely over physics, but with a particularly large number in geophysics. Invited speakers in geophysics are N. H. Ricker, Irwin Roman,

W. M. Rust, Jr., Ellis Strick, Victor Vacquier, and Raoul Vajk, and their papers are scheduled for Saturday morning and Saturday afternoon. Invited speakers in other fields of physics (some of these bordering on geophysics) are J. M. Burgers, G. F. Carrier, R. R. Grilly, Max Jammer, F. A. Matsen, J. Rud Nielsen, A. W. Nolle, V. H. Regener, D. H. D. Roller, Richard Rosa, S. A. Schaaf, G. K. Teal, James Terrell, M. W. Teucher, Otto Theimer, E. J. Workman, and J. R. Zimmerman.

Fifty-two **contributed papers** are distributed among seven sessions.

Post-deadline ten-minute papers, pertaining to very recent achievements of extraordinary importance, will be considered for admission to a special supplementary programme if the abstracts are received before Saturday, February 23, at the office of the Society (the address below). Mark these abstracts clearly as being offered for the Norman post-deadline programme, lest they find their way into the Washington-meeting file. The titles of such papers as may be accepted will be written on a blackboard near the registration desk, and opportunity for the presentation of these papers will be given at the end of Session P.

There will be no meeting of the **Council** of the American Physical Society at Norman.

Errata pertaining to abstracts in this issue will be published in a subsequent issue of this Bulletin if received not later than Monday, March fourth, by Miss Ruth Bryans, American Institute of Physics, 57 East 55th Street, New York 22, New York. Do not send in your abstract marked with corrections! Write out the corrections in the form "Instead of . . . read. . . ." Add nothing.

KARL K. DARROW, *Secretary*
American Physical Society
Columbia University
New York 27, New York

EPITOME OF THE 1957 SOUTHWESTERN MEETING

(Personal names are those of invited speakers.)

Friday Morning

10:00 A. Solid-state physics; Theimer. Union 165.

10:00 B. Theoretical physics; Jammer, Matsen. Physics 213.

10:00 C. Nielsen; molecules. Meacham Auditorium.

Friday Afternoon

2:15 E. Teal; general physics. Union 165.

2:15 F. Low-temperature physics; nuclear magnetic resonance; Nolle, Zimmerman. Physics 213.

2:15 G. Invited papers in fluid dynamics: Burgers, Rosa, Schaaf, Carrier. Meacham Auditorium.

Friday Evening

7:00 Banquet of the American Physical Society; Snyder. Ballroom, Oklahoma Memorial Union.

Saturday Morning

9:30 J. Nuclear physics; Terrell, Teucher. Union 165.

9:30 K. Roller, Workman, Regener, Grilly. Physics 213.

9:30 M. Invited papers in geophysics: Ricker, Strick, Rust, Vacquier. Meacham Auditorium.

Saturday Afternoon

1:30 N. Invited papers in geophysics: Vajk, Roman. Meacham Auditorium.

1:30 P. Electron physics; post-deadline papers, if any.

PROGRAMME

FRIDAY MORNING AT 10:00

Union, Room 165

(W. J. LEIVO presiding)

Solid-State Physics

A1. Evaporated Films of Magnetic Materials. C. E. BLEIL, *Research Staff, General Motor Corporation.*—Thin magnetic films have been made by evaporation of nickel and iron in a controlled atmosphere. Chemical analyses indicate that composition may be controlled effectively even though evaporation proceeds from a single furnace. X-ray and electron diffraction studies have confirmed the crystal structures. Films with regulated geometry and stoichiometry ranging from a few angstroms to >0.01 mm in thickness have been formed by this process. Preliminary magnetic studies will be reported.

A2. Hall Effect in Molybdenite. WILLIAM W. SCALES, *The Rice Institute.*—Measurements of the Hall effect in naturally occurring molybdenite were made over the temperature range 100°K–370°K using standard dc methods, and the resistivity was determined over the same range with a potentiometer The sample was so cut that the current paralleled planes of easy cleavage. The material was found to be *n*-type impurity semiconductor in this range. Curves of Hall mobility *vs* reciprocal temperature were drawn up using $\mu=(8/3\pi)R/\rho$ and found to have a definite maximum near the low-temperature end. The Hall effect was tested for linearity in the current and magnetic field up to 5 μa and 7 kilogauss, respectively, and linear variations were found in both cases. The data could be given an excellent fit on the low-temperature end (below 175°K) by postulating both a donor and an acceptor level but supposing there was excitation from the donor level only. The values determined in this way yielded a donor density of 5.9×10^{13} cm^{-3} and an excitation energy of 2.0×10^{-2} ev.

A3. Effects of Ionized Impurity Scattering on the Hall Coefficient in *P*-Type Germanium.* G. L. KENDALL, A. C. BEER, AND R. K. WILLARDSON, *Battelle Memorial Institute.*—Experimental studies of the Hall coefficient in single crystals of *p*-type germanium were carried out in the region of mixed scattering, i.e., where the contribution of both lattice vibrations and ionized impurities must be considered. The magnitude of the impurity scattering was varied both by controlling the temperature and by using specimens of different impurity contents. In particular, data are presented for specimens with acceptor concentrations ranging from 10^{13} to 10^{18}/cm^3 and at temperatures between 50 and 500°K. The data are analyzed using the two-band model as applied to hole conduction. In order to simplify calculations, the weak-field plateau of the Hall coefficient is determined experimentally. It has previously been pointed out[1] that the weak field Hall coefficient as a function of the amount of ionized impurity scattering has a minimum at approximately $\beta=0.67$, where $\beta=6\mu_L/\mu_I$. Calculations show that inclusion of the second band increases the value of β at which this minimum occurs and also augments its depth. These predictions are compared with the experimental data.

* This research was supported by the U. S. Air Force, through the Office of Scientific Research of the Air Research and Development Command.
[1] V. A. Johnson and K. Lark-Horovitz, Phys. Rev. **82**, 977 (1951).

A4. Temperature Dependence of Rayleigh Scattering in Sodium Chloride Crystals. I. C. A. PLINT, *University of Oklahoma.*—Preliminary investigations of the Rayleigh scattering of visible light in crystals of sodium chloride have revealed an unusual temperature dependence of the scattering power. The scattering power at a given wavelength has a broad minimum near 300°K and increases by a factor of two when the temperature is changed from 300°K to 230°K. Experimental details will be presented.

A5. Temperature Dependence of Rayleigh Scattering in Sodium Chloride Crystals. II. O. THEIMER, *University of Oklahoma.*—Possible explanations of the effects reported in the previous paper are discussed. The scattering is interpreted as caused by localized lattice imperfections in a "frozen" configuration which does not depend on the temperature. Only the polarizability of the scattering units is affected by the temperature, i.e., by the thermal fluctuations of the electrical crystal field at the centers. It is shown that this random local field rapidly increases with the temperature and strongly reduces the polarizability of the centers. Formulas are given for the case of impurity atoms, vacancies, and pairs or clusters of vacancies. The scattering by cation vacancies gives the best agreement between theory and experiment.

A6. Frequency Spectrum of the Lattice Waves of LiF.* CLARK OLIPHINT, *The Rice Institute.*—Recent work[1] at The Rice Institute showed that the specific heat curve for LiF could be well fitted with a Debye function, based on observed elastic constants, plus an Einstein function. In an attempt to justify the use of the Einstein term, a calculation of the frequency spectrum of LiF has been made. A set of force constants was chosen which connected each fluorine ion with the nearest and next-nearest fluorine ions. Each lithium ion, however, was assumed to be connected only to the nearest fluorine ions. In a sense, then, the lithium ions were isolated from one another. If appropriate values are chosen for these force constants, the optical branch of the frequency-*vs*-wavenumber curve becomes quite flat. This means that half the normal modes have essentially the same frequency, which justifies the use of the Einstein approximation.

* This work was supported in part by the National Science Foundation.
[1] C. V. Briscoe and C. F. Squire, Bull. Am. Phys. Soc. Ser. II, **2**, 18 (1957).

A7. Relation of Crack Extension Force to Fracturing of Materials. HERSCHEL L. SMITH AND JOSEPH A. KIES, *U. S. Naval Research Laboratory.*—This paper contains a discussion on further procedures which have been developed at the U. S. Naval Research Laboratory for determining the role of a crack extension force tendency in the propagation of fracturing in solid materials. Experimentally determined values of the crack extension force for the onset of unstable fast fracturing is given for a variety of materials and test methods. One makes use of a critical value of crack extension force by determining the stress which exists in the vicinity of a crack for a particular material and configuration subjected to a desired loading condition. It is then possible to say how close the existing stress system is to becoming critical. A working formula for this prupose, provided by G. R. Irwin, is stated, and an explanation is given on how it may be used in connec-

tion with a strain-gage technique to evaluate the seriousness of a crack in a structure. Several other formulas derived by Irwin to fit various loading conditions are given.

A8. Use of the Electrical Potential at the Break of an Adhesive Bond in Studying Elastic Pulses and Waves During Break. SELBY M. SKINNER, E. L. KERN, M. K. PARK, AND N. M. TRIVISONNO, *Case Institute of Technology.*—The shape of the oscillographic potential curve obtained during the break of an adhesive bond depends, in the early stages of break, upon the rate of removal of adhesive and, throughout the whole break, upon the rate at which the space charge within the adhesive is moving away from the oppositely charged adherend. This permits study of the nature of the mechanical response of the system during the milliseconds of actual break. Since the sample is destroyed in the process, it is desirable that a series of samples be prepared, as nearly identical as possible. With a set of glass-polyester-glass adhesion samples yielding nearly identical traces on break, initial rise times of the order of 10^{-7} sec have been observed, the limiting factor being the circuit constants. This time is therefore an upper bound for the time required to break an already stressed local adhesion bond between the polyester and glass. After separation of adhesive, elastic waves and pulses cause characteristic alterations in the shape of the trace. Pulses can be detected as compressions or as rarefactions. In the samples mentioned, and in aluminum-polymethylmethacrylate-aluminum samples, characteristic effects are observed at 20 and 390 μsec, the former being the result of the characteristics of the sample and its support and the latter of the tensile test machine.

Invited Paper

A9. Vibrations of Solid *n* Paraffins. OTTO THEIMER, *University of Oklahoma.* (30 min.)

FRIDAY MORNING AT 10:00

Research Institute Physics, Room 213

(J. S. LEVINGER presiding)

Theoretical Physics

B1. On the Use of the Born-Oppenheimer Approximation in Molecular Problems. A. D. LIEHR, *Bell Telephone Laboratories.*—In 1927 Born and Oppenheimer[1] developed a method by which one may separate the eigenfunctions and eigenvalues of molecular Hamiltonians, in the zeroth order, into distinct terms corresponding to electronic motions for fixed nuclei, nuclear vibratory motions, and nuclear rotational motions. However, in the process of setting up their approximation scheme, Born and Oppenheimer assumed that the Schrödinger equation describing the electronic motions for fixed nuclei had been solved for all nuclear configurations. Thus they were able to base their approximation scheme on a power series expansion of the Schrödinger equation about an arbitrary nuclear configuration. In general, however, we have available only approximate solutions of the electronic Schrödinger equation (fixed nuclei) for a few selected nuclear configurations. Therefore, we cannot use the original Born-Oppenheimer method for solving the complete molecular Schrödinger equation without some modifications. In this paper a modification of the Born-Oppenheimer scheme which takes into account the poorness of the available electronic wave functions will be presented.

[1] M. Born and R. Oppenheimer, Ann. Physik **84**, 457 (1927).

B2. Pion Production Contribution to Electron-Deuteron Elastic Scattering.* H. S. VALK,† *Washington University.*—Recent studies, both experimental[1] and theoretical,[2] indicate the possibility of direct pion production in electron-nucleon scattering. An estimate is made of the contribution of this effect to the high-energy electron-deuteron elastic scattering cross section. The contribution is taken into account phenomenologically by the addition of a suitable imaginary term to the usual interaction Hamiltonian for the electron-deuteron system. A numerical evaluation of this term is made by comparing the predicted electron-nucleon inelastic cross section with that expected from the experimental results on photopion production using the Williams-Weizsäcker approximation. Within the present range of experimental energies, the correction appears to be small. The results of this procedure will be reported.

* Supported in part by the Office of Naval Research and OSR.
† Shell Fellow in Physics.
[1] Panofsky, Newton, and Vodh, Phys. Rev. **98**, 751 (1955).
[2] R. B. Curtis, Phys. Rev. **104**, 211 (1956).

B3. Relativistic Power Absorption. T. A. MOSS AND J. S. LEVINGER, *Louisiana State University.*—The integrated power absorption for any classical nonrelativistic oscillator is[1,2] $\pi E_0^2 e^2/4m$ (charge e, mass m, electric field amplitude E_0). We are calculating relativistic corrections of order v^2/c^2: first those caused by use of the relativistic classical equation of motion; and second those caused by retardation effects for the electromagnetic field. The first corrections are found using Van Vleck's methods, and relativistic corrections for the relation between action and the oscillator's amplitude. For the special case of an isotropic three-dimensional simple harmonic oscillator, the nonrelativistic result is multiplied by a factor $(1-5\bar{T}/3mc^2)$, where $\bar{T}$ is the time average of the kinetic energy. We will present results for the second corrections.

[1] J. H. Van Vleck, Phys. Rev. **24**, 347 (1924).
[2] W. Heitler, *Quantum Theory of Radiation* (Oxford University Press, Cambridge, 1954), third edition, p. 36.

B4. The Λ^0-Nucleon Interaction. J. T. JONES, JR., *North Texas State College* (introduced by L. F. Connell, Jr.).—In previous, preliminary calculations[1] concerning a phenomenological potential for the Λ^0-nucleon interaction, the interaction between two nucleons in light hyperfragments was assumed to be the same as that for two nucleons in light nuclei and, for simplicity, all interactions other than the central interaction were neglected. Furthermore, the trial wave functions used were chosen to be spatially symmetric. Before

attempting to account for tensor forces between nucleons in such calculations, one must determine whether in the central interaction approximation the modification of the symmetry of the trial wave functions to include the effect of nucleon p states will raise materially the calculated binding energy of the system. Variational calculations with such modified trial functions are being completed for the hypertriton.

[1] J. T. Jones, Jr., and J. M. Keller, Nuovo cimento (to be published).

Invited Papers

B5. The Concept of Simultaneity: Its History and Present Status. MAX JAMMER, *University of Oklahoma.* (30 min.)

B6. The Permutation Group and Electron Quantum Mechanics. F. A. MATSEN, *University of Texas.* (40 min.)

FRIDAY MORNING AT 10:00

Meacham Auditorium

(D. C. SMITH presiding)

Invited Paper

C1. Raman Spectra of Compounds in Different States of Aggregation. J. RUD NIELSEN, *University of Oklahoma.* (30 min.)

Molecules

C2. Ionization of LiH. J. MILLER, O. PLATAS, R. HURST, AND F. A. MATSEN, *University of Texas.*—Employing for both LiH and LiH^+ the Slater orbitals $1s$, $2s$, $2p_\sigma$ on Li and $2s$ on H with orbital exponents 2.70, 0.65, 0.65, and 1, and internuclear separation 3.0 a.u. the vertical ionization energy was found to be 7.93 ev, to be compared with 5.4 ev for the Li atom itself. Six structures were considered for both ion and molecule. For LiH the important structures are $1s^22s$, $1s$(0.45108); $1s^22p$, $1s$(0.26378); and $1s^2$, $1s^2$(0.22682), while for LiH^+ only $1s^2$, $1s$(0.99624) makes a significant contribution.

C3. On the Electronic States of F_2. KATSUNORI HIJIKATA, *University of Cincinnati.**—The electronic states of fluorine molecules are calculated by ASMO method. All the 18 electrons and 120 electronic configurations are taken into account. The calculation is based on the hydrogen-like atomic orbitals and is done for the interatomic distances 1.221 A and 1.526 A. The single configuration does not show any binding, and the configurational interaction lowers the energy of the ground state ($^1\Sigma_g^+$) to -0.938 and -2.216 ev for these distances compared with that of two separate fluorine atoms in the ground state (^3P). Fitting them to the Morse curve by the use of vibrational Raman frequency 892.1 cm^{-1}, the dissociation energy and the equilibrium distance are calculated to be 2.281 ev and 1.452 A. If the effect of $1s$ electrons is neglected, the dissociationtenergy becomes a little higher (3 ev). The excitation energy from the ground state to the lowest singlet excited state ($^1\pi_u$) is 4.41 ev (experiment: 4.28). The behaviors of the excited states do not contradict the experiment, except that the potential minimum of ($^1\pi_g$) exists at much longer interatomic distance than the experimental value 1.282. A triplet state ($^3\pi_u$) is expected to be below the lowest excited singlet state. The accuracy of the ASMO method itself is also discussed.

* The greater part of this work was done at Harvard University.

C4. Infrared and Raman Spectra of CF_3-CH_2Br and CF_3-$CHClBr$.* J. RUD NIELSEN AND ROSE THEIMER, *University of Oklahoma.*—The infrared absorption spectra of gaseous 1,1,1-trifluoro-2,2-dibromoethane and 1,1,1-trifluoro-2-chloro-2-bromoethane have been obtained with a 1-m cell and a Perkin-Elmer double-pass spectrometer equipped with LiF, NaCl, and CsBr prisms. The Raman spectra of the compounds in the liquid state have been photographed with a 3-prism glass spectrograph of linear dispersion 15 A/mm at 4358 A. Depolarization ratios have been measured for the former compound. The fundamental vibrational frequencies have been assigned, and the spectra have been interpreted in detail. Approximate values have been determined for the heights of the potential barriers opposing internal rotation. Thermodynamic functions have been calculated for the compounds in the ideal-gaseous state at various temperatures.

* This work has been supported by the U. S. Atomic Energy Commission.

C5. Infrared and Raman Spectra of 1,2-Difluorobenzene. C. J. HALLEY, N. A. NARASIMHAM, J. RUD NIELSON, AND C. A. PLINT.*—The infrared absorption spectrum of gaseous 1,2-difluorobenzene has been obtained with the aid of a 1-m cell and a Perkin-Elmer Model 112 double-pass spectrometer. The Raman spectrum of the compound in the liquid state has been photographed with a 3-prism glass spectrograph of linear dispersion 15 A/mm at 4358 A, and depolarization ratios have been measured. The 30 fundamental vibrational frequencies have been assigned, and the spectra have been interpreted in detail.

* This work has been supported by the U. S. Atomic Energy Commission.

C6. Microwave Spectrum of ClO_2 and a Method for Analysis of Asymmetric Free Radical Spectra.* JAMES C. BAIRD, JOHN RASTRUP-ANDERSEN, AND GEORGE R. BIRD, *The Rice Institute.*—The microwave spectrum of ClO_2 is an array of closely spaced quartets of absorption lines, each arising from the interaction of the chlorine nuclear spin ($I=\frac{3}{2}$) with the resultant (J) of molecular rotation (N) and electron spin ($S=\frac{1}{2}$). The difficulty of pairing quartets associated with the same rotational transition has pervented analysis of the spectrum. Moments of inertia and a trial spectrum for ClO_2 have been calculated from the extensive ultraviolet data of Coon and co-workers and the infrared study of Nielsen and Woltz. Unfortunately, the trial spectrum lacks the extreme reliability required for pairing quartets. The analysis of this spectrum began with a search for irregular

multiplets, followed by an inspection for sets of equal frequency differences among these. A cluster of twelve lines at 34.3 kMc and a group of ten at 37.2 kMc exhibit several sets of equal differences and thus are paired as parts of a single rotational transition. This is tentatively assigned $3_{13} \rightarrow 4_{04}$, probably of $Cl^{35}O_2$, consistent with the trial spectrum. A septet at 35.5 kMc may be part of the corresponding isotopic transition. The analysis of rotational and magnetic parameters may proceed from this point. We are grateful to D. F. Smith for communicating his extensive microwave data and to J. B. Coon for advice.

* Supported by The Research Corporation and by The Robert A. Welch Foundation.

C7. Inequality of Bond Distances in ClO_2. J. B. Coon, J. K. Ward, and C. M. Loyd, *A and M College of Texas.*—Four ν_1' progressions (a), (b), (c), and (d) dominate the appearance of the 3000–5000 A absorption system of ClO_2 vapor. If it is assumed that $r_1''=r_2''$ and $r_1'=r_2'$, where r designates a Cl-O bond distance, the four progressions must be given the excited state assignments (a), ($\nu_1'00$); (b), ($\nu_1'10$); (c), ($\nu_1'02$); and (d), ($\nu_1'04$). All four progressions are assigned to the (000) level of the ground state. However, a calculation of condon overlap integrals leads to an intensity ratio $I(c)/I(a) = 0.02$ which compares poorly with the observed ratio 0.5. Similarly, the calculated value of $I(d)/I(a) = 0.0006$ compares poorly with the observed value of about 0.15 for this ratio. The large value of the observed intensities of progressions (c) and (d) may be explained by assuming a slight difference in bond distances for the excited state (or the ground state). This alters the selection rules, and the assignments (c), ($\nu_1'01$) and (d), ($\nu_1'02$) may be made. On the basis of this interpretation, large intensity ratios are possible. Calculations are being made to test whether each of the foregoing observed intensity ratios is explained by the same inequality of bond distances for the excited state.

C8. Effects of High Pressure on the Near Ultraviolet Absorption Spectrum of Liquid Benzene. W. W. Robertson and S. E. Babb, Jr., *The University of Texas.*—Vodar and colleagues have reported that the wavelength of absorption in the near ultraviolet of pressurized liquid benzene shifts to the red as the square of the pressure. Shuler's theory of the self-complexing of two benzene molecules was used in interpreting the results. Robertson, Babb, and Matsen found that the wavelength shift of benzene in dilute solution was continouus with pressure and of decreasing slope. The shift was linear with dielectric constant or density of the solvent, and Shuler's interpretation was erroneous. A plot of wavelength *vs* low-frequency dielectric constant for benzene over a concentration range from dilute to 100% is linear with the same slope as obtained for the pressurized dilute solution, indicating no shift due to resonance interaction. At concentrations up to 75% benzene and pressures up to the solidification point at 30°C, the wavelength shift with pressure has a decreasing slope. Vodar's results obtained at 50°C and pressures up to 1500 atmospheres differ from those obtained in dilute solution at room temperature by at most little more than 1 A. The small but important differences between the curves may be the result of the increased compressibility of the benzene at the higher temperature and lower pressures.

C9. Infrared Spectra and Geometrical Structure of Aromatic-Halogen Charge Transfer Complexes. Eldon E. Ferguson, *U. S. Naval Research Laboratory.*—Solutions of many aromatic and halogenated compounds give rise to molecular complexes of the donor-acceptor type, wherein electron transfer occurs. The geometrical structure of the simple benzene-halogen binary complexes, a matter of some theoretical interest, previously has been unknown. The infrared spectra of benzene-iodine and benzene-bromine solutions in the region of 2–15 μ show two of the inactive benzene fundamental vibration bands to be appreciably enhanced in intensity. These are the A_{1g} 992 cm^{-1} band and the E_{1g} 850 cm^{-1} band. Seven other observed inactive vibrations do not show increased intensity in these solutions. This is precisely the result expected if the halogen axis is coincident with the benzene C_6 axis and is considered to be a strong argument in favor of such an "axial" structure. Any other possible structure should cause all nine observed inactive fundamentals to be enhanced. In addition, the infrared spectrum of a hexadeuterobenzene-iodine solution has been investigated, and the same two fundamentals are enhanced, in this case the A_{1g} fundamental having a frequency 944 cm^{-1} and the E_{1g} fundamental lying at 662 cm^{-1}. This offers strong confirmation of the "axial" geometry hypothesis.

Friday Afternoon at 2:15

Union, Room 165

(V. H. Regener presiding)

Invited Papers

E1. Trends in Semiconductors. G. K. Teal, *Texas Instruments Incorporated.* (30 min.)

General Physics

E2. Precision Integration of Beam Current. R. J. Helmer and A. Hemmendinger, *Los Alamos Scientific Laboratory.*—A method of current integration using rapid transfer of small quantities of charge is described. The input current charges a capacitor, the voltage across which is measured by an electrometer. A servo-loop is used to discharge the capacitor in small increments but at a high repetition rate so that the integration is practically continuous. There is no dead time, and capacitor soakage effects are minimized by reversal of the metering capacitor for each cycle. The output is in the form of pulses suitable for driving a scaler. Since the input potential is maintained near zero, the input impedance is low—of the order of 50 000 ohms—and poor insulation in the input circuit can be tolerated. Also, the device can be calibrated without a source of high voltage. The calibration constant for each of five scales has changed less than $\pm 0.1\%$ during an observation period of eight months. The design of an instrument for use in the range 0.1 to 30 μa will be discussed.

E3. Area Measurements as a Method of Determining Ionization in Nuclear Emulsions. W. Z. Osborne and R. A. Howard, *University of Oklahoma.*—Reproducibilities ob-

served for grain counting, gap length, and photometric methods of measuring ionization leave much to be desired, particularly in electron-sensitive emulsions. The procedures used and the results obtained are given for an investigation of the reproducibility of ionization measurements in which was employed a new parameter suggested by Fitzpatrick,[1] namely, projected track area; these measurements were made with a planimeter on photomicrographs of the tracks. Ilford G5 pellicles, exposed* to monoergic proton and positive pion beams, were processed using the temperature development method. Measurements were carried out on ten proton tracks, seven pion tracks, and seven muon tracks, all of which terminated within the emulsion. The total track length examined was 2.8 cm. The method yields results which are more reproducible than are those obtained using any of the other three methods. Further, observer subjectivity is negligible and the results are insensitive to emulsion transparency and depth to within 15 μ of either surface of the undeveloped emulsion.

[1] P. M. Fitzpatrick, unpublished Ph.D. dissertation, Department of Physics, University of Oklahoma (1955).
* Exposure through the courtesy of Professor Marcel Schein and the University of Chicago cyclotron staff.

E4. Fast Neutron Detector.* CLAUDE F. WILLIAMSON AND EMMETT L. HUDSPETH, *University of Texas.*—A fast neutron detector has been constructed from eleven plastic scintillating sheets, each 1 in.×1 in. and of thickness 30 mils. These sheets are stacked together; each sheet is completely covered, except for one edge, with a highly reflective evaporated aluminum film. The edges of even sheets are viewed by one photomultiplier, and the edges of odd sheets are viewed by a second photomultiplier. The pulses of each photomultiplier are amplified and fed into an anti-coincidence circuit† especially developed for this purpose. When flashes appear in two or more sheets, the anti-coincidence circuit will (within limits defined by thickness of sheets and bias settings) reject the event. Such a detector therefore will be relatively insensitive to γ radiation. By using a large number of plastic sheets, the efficiency for fast neutrons may be made quite large. Detection of 4.7-Mev neutrons with the present counter showed a pulse-height distribution with a short plateau and an efficiency of approximately 4%. Further experiments with detectors of this type are now in progress.

* Assisted by the U. S. Atomic Energy Commission.
† Proposed by Professor W. E. Millett and Dr. N. A. Bostrom and developed by one of us (CFW).

E5. An Inflection Focusing Mass Spectrometer. J. A. RICKARD, *Humble Oil and Refining Company.*—A theory of inflection focusing for mass spectrometers was developed independently by Hintenberger[1] and Kerwin.[2] A mass spectrometer based on this theory has been constructed and used routinely for precision measurements of isotopic ratios. The instrument is of all-metal construction and has a 9-in. radius of curvature in a 40° sector magnetic analyzer. The validity of theoretical expressions[2] for dispersion has been verified experimentally. The achievement of second-order direction focusing permits a resolution (1% valley between peaks) of approximately 400 amu. Despite greater axial defocusing and more stringent vacuum requirements necessitated by the longer ion path, the advantages of better focusing, smaller magnetic fields, and removal of the ion source from the vicinity of the magnetic analyzer indicate that inflection focusing is slightly superior to first-order direction focusing for many mass spectrometer applications.

[1] H. Hintenberger, Rev. Sci. Instr. **20**, 748 (1949).
[2] L. Kerwin, Rev. Sci. Instr. **20**, 36 (1949).

E6. A Stable Instrument Platform. FOREST K. HARRIS, *National Bureau of Standards* (introduced by William Schriever).—The effective isolation of an instrument from mechanical disturbances requires a soft mechanical coupling and large damping. Analysis of a system with one degree of freedom shows that the type of damping is important. For coupled damping, disturbances increase with increased damping; for independent damping, disturbances are decreased. An inexpensive isolating system with independent damping has been studied. It consists of two nested inner tubes carrying a heavy platform. The tubes are connected together and inflated to a pressure of 6–8 cm Hg. The platform is weighted with lead shot in oil, arranged in two compartments so that its center of mass is in its plane of contact with the upper supporting tube. Damping results from air flow between the supporting tubes and from surface motions of the oil in the shot compartments. The assembly is shielded from air currents. Motions of the platform, mounted on a laboratory wall bracket, were observed by means of the interference pattern between an optical flat and a liquid surface in a shallow dish mounted on the platform. It was found that these motions were only slightly greater than the microseisms of a concrete pier resting on undisturbed ground 30 ft below the basement level of the laboratory.

E7. Correlation of Adjacent Gravimeter Surveys. V. L. JONES, *Geophysicist, Tulsa, Oklahoma* (introduced by William Schriever).—Gravity surveys conducted on adjacent areas at different times, by different personnel and with different gravimeters, often result in the two surveys not correlating properly at their common boundary. If the calibration for one instrument is incorrect, and the data obtained with this instrument are computed by using this calibration, the resulting contours are severely distorted along the common boundary of the two surveys. A correct meter factor may be computed for this gravimeter by extrapolating several profiles from the adjacent survey, made with a correctly calibrated meter, into the area surveyed with the faulty meter. This may be accomplished by means of an extrapolation formula derived by the author.[1] A least-squares method for calculating the correct meter factor is presented. The gravity values computed with this corrected factor will contour smoothly across the common boundary.

[1] V. L. Jones, Geophysics **21**, No. 4, 1047 (October, 1956).

E8. A High Radiometric Anomaly Caused by Fallout and Its Decay. J. O. PARR, JR., *Consulting Geophysicist, San Antonio, Texas.*—A large and intense radiometric anomaly, probably attributable to fallout, is described. The maximum gamma radiation was twenty-five times the normal radiation. Radiation in excess of five times-normal was observed over an area of one-hundred square miles. The extent of the anomaly was correlated with rainfall prior to the initial readings. deposition of radioactive material was restricted to the top surface only. Five successive runs of the same traverse over a period of nearly a year show cumulative decay of the anomalous readings to be substantially normal.

E9. The Vapor Pressure Equation. L. SALTER, *Wabash College* (introduced by William Schriever).—The vapor pressure equation for an ideal crystal in equilibrium with its vapor is discussed in the light of recent developments in the theory of lattice dynamics. In particular, it is shown that the temperature variation of $\log p$ can yield information about crystalline parameters of interest, such as the maximum lattice vibration frequency. The case of argon, now reasonably well understood from both the lattice dynamical and gaseous phase points of view, is discussed in detail.

E10. Two-Crystal Continuous Wave Method for Measuring Ultrasonic Absorption. R. S. MUSA, *Agricultural and Mechanical College of Texas* (introduced by Melvin Eisner).—A two-crystal interferometer has been developed for use with continuous waves in ultrasonic measurements. The theory

of the instrument is analyzed with special reference to approximate solutions in the regions of high and low absorptions. Good signal-to-noise ratios are obtained at low acoustic power levels through the use of narrow band techniques. Good results were obtained using a standard signal generator and communication receiver. Experimental data taken in the range 5–55 Mc will be presented and discussed.

E11. Properties of Liquids as Revealed by Accurate Measurements. GEORGE ANTONOFF, *33 Tier Street, New York 64, New York.*—It was shown by myself that liquids change their properties with temperature *discontinually*. This was shown in a long article published in Phil. Mag. in 1925. Introduced into America in 1932, under W. D. Bancroft, who endorsed my views, it has not received recognition in this country, because, it was said, the results were based on figures of only one author. Since then, many new data have been published, and they all show the same results. Particularly, I emphasize the data on *vapor pressures*, which were obtained by three investigators on the International Committee on Steam Properties.[1] In the opinion of Keyes, these data are accurate enough for my purposes. However, it has become fashionable to doubt the results on account of *smoothing*. It is true that the methods used have not always been scientific. However, among them are found results of direct experiments, and they show the same effects.

[1] F. G. Keyes, J. Chem. Phys. **17**, 923 (1949).

FRIDAY AFTERNOON AT 2:15

Research Institute Physics, Room 213

(C. F. SQUIRE presiding)

Low-Temperature Physics; Nuclear Magnetic Resonance

F1. Thermomechanical Effect in Helium II in Wide Capillaries.* F. A. ROMBERG AND H. E. RORSCHACH, *The Rice Institute.*—Experiments have been performed on the thermomechanical effect in an apparatus of the type used by Allen and Reekie[1] with a 1-mm capillary. The difference (Δh) between the reservoir level and the bath level is observed as a function of heat current. For heat currents below a critical value, Δh is less than 1 mm, which is consistent with the two-fluid theory including the Gorter-Mellink mutual friction. At the critical value, which is an order of magnitude greater than the inversion heat current of Allen and Reekie, Δh increases sharply to over 1 cm, and vapor appears in the upper part of the heater bulb. On lowering the heat current below the critical value, Δh decreases linearly with heat current. A dependence of Δh on heat current, without critical effects, is also observed in helium I.

* Supported in part by a National Science Foundation grant.
[1] Allen and Reekie, Nature **144**, 475 (1939).

F2. Magnetic State of an Iron Alum Single Crystal Below 0.1°K.* C. W. DEMPESY, J. T. RICHARDSON,† R. C. SAPP, AND C. F. SQUIRE, *The Rice Institute.*—Ballistic measurements using a 5-sec period galvanometer of the isentropic differential susceptibility of ferric ammonium alum, which was cooled by adiabatic demagnetization to a temperature below its Curie point, have been made on a prolate ellipsoidal single crystal specimen of axial ratio 1.6:1. The long axis was parallel to a [111]-axis of the cubic lattice. The small primary field and a steady external field could be applied parallel to this axis. Between the entropy values $0.35R$ and $0.65R$ the experimental susceptibility in zero applied field is constant at $\chi = 0.36$ and falls by only about 3% at $S = 0.25R$. At the lowest entropy we found no rise in the susceptibility as a function of steady external fields. These were taken up to 330 gauss, where the induced magnetization reached 60% of saturation. These results show similarity to the antiferromagnetic ordering of a face-centered cubic lattice of ions which has been studied by Anderson[1] and by Smart.[2]

* Assisted by grants from The Robert A. Welch Foundation.
† Now at Humble Oil and Refining Company, Baytown, Texas.
[1] P. W. Anderson, Phys. Rev. **79**, 705 (1950).
[2] J. Samuel Smart, Phys. Rev. **86**, 968 (1952).

F3. Low-Temperature Quartz Crystal Units for Frequency Control. FRANCIS P. PHELPS, *National Bureau of Standards Boulder Laboratories.*—All quartz crystals used for frequency control age, i.e., the frequency of the crystal changes as time goes on. For crystals fabricated with the utmost care, such as those used to control the frequency of WWV, the residual drift is of the order of 1 part in 10^9 per day. There is evidence that by operating the crystal at some very low temperature (liquid helium temperature, for instance, 4°K) a reduction of several orders of magnitude will be obtained in the aging rate. Crystals designed to operate at ordinary temperatures cannot be expected to give optimum performance at such low temperatures. In connection with the design of a crystal unit for operation at these low temperatures, the frequency *versus* temperature characteristics of a family of crystal units have been measured. By cutting the oscillator plate at a suitable crystallographic orientation, the positive and negative temperature coefficients of quartz may be made to neutralize one another at any desired temperature to give a resultant zero coefficient of frequency. In the present work, the angle of cut *versus* the temperature at which frequency-temperature coefficient is zero has been determined. The results are given in the form of graphs.

F4. Nuclear Magnetic Resonance in Solid Hydrogen.* GEORGE W. SMITH AND C. F. SQUIRE, *The Rice Institute.*—The nuclear magnetic resonance in solid hydrogen of 75% and 50% ortho concentration has been studied in the liquid helium temperature range. In normal hydrogen the appearance at 1.5°K of side peaks of 40-gauss separation as observed by Hatton and Rollin (1949), Reif and Purcell (1953), and Sugawara *et al.* (1955) has been noted. In addition, the "humps" of about 80-gauss separation reported by the latter two groups at about 1.2°K have been detected at 1.4°K with low rf levels. For 50% ortho, the line width increased from 4.5 gauss to 6.5 gauss on lowering the temperature from 4.2° to 1.4°K. Pressures up to 41 atmospheres have been applied to both samples with no appreciable effect on line shape. Solid hydrogen has a large compressibility (-5×10^{-4} atmos^{-1}), but our modest pressures would produce an estimated change of only 0.025 A in the 3.75-A intermolecular separation, R. However, because of the cooperative nature of the rotational transition in the ortho molecule resulting in the appearance of the side peaks, one might have expected a small change in R to affect the transition and hence the line shape. Apparently higher pressures are needed to do this.

* Supported by a grant from The Robert Welch Foundation.

F5. Nuclear Magnetic Resonance in Single Crystal LiF down to 1.5°K.* FRANK J. LOW AND C. F. SQUIRE, *The Rice Institute.*—The nuclear magnetic resonance of Li^7 and of F^{19} in a single crystal of optical purity LiF has been studied from room temperature to 1.5°K examining line width and spin-lattice relaxation time, T_1. We find that both the Li and F have a line width of 12.5 gauss which is constant with temperature, and this agrees well with the studies by Rollin *et al.*[1] and also those of Pound.[2] The long relaxation time T_1 (order, 1 min) is of principle interest in these studies even though governed by the very small traces of paramagnetic impurity.[3] These matters are linked with our understanding of the lattice vibration spectrum of LiF.

* Assisted by grants from The Robert A. Welch Foundation.
[1] Rollin, Hatton, Cooke, and Benzie, Nature **160**, 436 (1947).
[2] R. V. Pound, J. Phys. Chem. **57**, 743 (1953).
[3] N. Bloembergen, Physica **15**, 386 (1949).

F6. Nuclear Spin Resonance Line Width Measurements of Polyethylene. R. L. COLLINS, *Phillips Petroleum Company.*—The proton spin resonance spectrum of polyethylene consists of two superimposed lines. The narrow line is attributed to the amorphous phase[1] and the broad line to the crystalline phase. The width of the narrow line was measured at various temperatures from 25–130°C for Alathon 10, Alathon 14, DYNH, and Marlex* 50 polyethylene, and it was found to vary with temperature. The results have been interpreted using the theory of motional narrowing,[2] which indicates that the product of temperature and line width is proportional to the viscosity. A plot of log of line width times temperature *versus* reciprocal temperature is linear for Marlex 50 polyethylene and is curved for the other three. The linearity is believed to be the result of the simple structure of the material, and the slope yields an activation energy of 8200 cal/mole. The curvature of the other data is believed to be the result of extensive branching which causes a change of composition of the amorphous phase upon cooling, and the apparent activation energy varies from 11 800 cal/mole at 130°C to 4900 cal/mole at 25°C.

[1] C. W. Wilson, III, and G. E. Pake, J. Poly. Sci. **10**, 503 (1953).
* A. Trademark of Phillips' family of olefin polymers.
[2] Bloembergen, Purcell, and Pound, Phys. Rev. **73**, 679 (1948).

Invited Papers

F7. Nuclear Magnetic Resonance and Molecular Motion. A. W. NOLLE, *University of Texas.* (30 min.)

F8. Selected Applications of Nuclear Magnetic Resonance. J. R. ZIMMERMAN, JR., *Magnolia Petroleum Company.* (40 min.)

FRIDAY AFTERNOON AT 2:15

Meacham Auditorium

(R. G. FOWLER presiding)

Invited Papers in Fluid Dynamics

G1. Magnetohydrodynamics. J. M. BURGERS, *University of Maryland.* (30 min.)

G2. Application of Magnetohydrodynamics to Flight. RICHARD ROSA, *Avco Research Laboratories.* (30 min.)

G3. Hypersonic Viscous Interaction at a Leading Edge. S. A. SCHAAF, *University of California, Berkeley.* (30 min.)

G4. Propagation of Shock Waves in Dust-Filled Gases. G. F. CARRIER, *Harvard University.* (30 min.)

FRIDAY EVENING AT 7:00

Ballroom, Oklahoma Memorial Union

(H. D. SMYTH presiding)

Banquet of the American Physical Society

After dinner talk: **Heredity and Modern Life.** LAURENCE H. SNYDER, *University of Oklahoma.*

SATURDAY MORNING AT 9:30

Union, Room 165

(A. HEMMENDINGER presiding)

Nuclear Physics

J1. Absolute Intensities of *L* X-Rays and Gamma-Rays in RaD Decay.* R. W. FINK, *University of Arkansas.*—The absolute intensity (F) of L x-rays/RaD disintegration is $0.23_3 \pm 0.02$ by gas proportional spectrometry on carrier free RaDEF sources. Relative intensities of x-rays are $L_\alpha : L_\beta : L_\gamma$ :: 1.1 : 0.19. The intensity relative to that (R) of the single,[1,2]

46.5-kev pure $M1$ gamma ray is $F/R=5.1\pm0.5$. From data taken with a 3×3-in. NaI(Tl) scintillation spectrometer, the intensity of the gamma ray is $R=0.045$/dis. Taking the L-shell ionizations/dis (I) to be 0.62[2], the mean L fluorescence yield of bismuth is $0.38_9\pm0.02$. Since $(F/I)=(F/R)(R/I)$, where (R/I) is the reciprocal of the total L conversion coefficient, the latter from experiment is 13.3 ± 2.0, the major error arising from correction of (F/R) for contribution by Compton backscattered quanta,[3] which amounts to some 10 to 20%. The value interpolated from Rose's tables is 17.85, based on a point-charge nucleus. Better agreement is obtained with a value of about 12.7 from Sliv and Listengarten,[4] who corrected for finite nuclear radius.

* Supported in part by the National Science Foundation and the U. S. Atomic Energy Commission.
[1] Fink, Warren, Edwards, and Damon, Phys. Rev. **103**, 651 (1956).
[2] Wu, Boehm, and Nagle, Phys. Rev. **91**, 319 (1953) (I=0.64); W. Stanners and M. A. S. Ross (I=0.60) (private communication from N. Feather).
[3] R. W. Fink and B. L. Robinson, Rev. Sci. Instr. **27**, 712 (1956).
[4] L. A. Sliv and M. A. Listengarten, Zhur. Eksptl. i Teort. Fiz. **22**, 29 (1952).

J2. Radiations of U^{237}.* M. E. Bunker, J. P. Mize,† and J. W. Starner, *Los Alamos Scientific Laboratory.*—The radiations of U^{237} have been studied with a 141-gauss, 180° permanent magnet spectrograph and gamma-scintillation spectrometers. The energies (in kev) and the assigned multipolarities of the transitions in Np^{237} following beta decay of U^{237} are: 26.3($E1$), 33.2($M1+E2$), 43.4($M1+E2$), 59.6($E1$), 165.0($E2$), 208.4($M1$), 234.8($M2$), 268.0($E1+M2$), 332.9($E2$), 335.9($M1$), 369.2, and 371.5. We have found no evidence for the 433-kev transition reported previously.[1,2] The multipolarity assignments are based on L-subshell conversion electron data. The foregoing gamma energies, together with the results of scintillation coincidence measurements, indicate the existence of the following energy levels in Np^{237}: 33.2, 59.6, 103.0, 268.0, 332.9, 335.9, 369.2, and 371.5 kev. Delayed coincidence measurements indicate that the half-life of the 268.0-kev level is $5.4\pm0.5\times10^{-9}$ sec. Spin and parity assignments for the various energy levels based on the experimental data and nuclear model considerations will be presented.

* Work performed under the auspices of the U. S. Atomic Energy Commission.
† Now at Combustion Engineering.
[1] Wagner, Freedman, Engelkemeir, and Huizenga, Phys. Rev. **89**, 502 (1953).
[2] S. A. Baranov and K. N. Shlyagin, "Conference of Academy of Sciences USSR on Peaceful Uses of Atomic Energy," Phys. Math. Sci. 251 (July, 1955); Consultants Bureau Translation, p. 183.

J3. Neutron Spectrum from the $T+t$ Reaction. S. J. Bame, Jr., and Wallace T. Leland, *Los Alamos Scientific Laboratory.*—The neutron spectrum at 0° from a tritium gas target bombarded with 1.48-Mev tritons has been determined, using a hydrogenous radiator-type neutron spectrometer. Those protons scattered in the forward direction by the neutrons passed through a system of two proportional counters and an aperture and were stopped in a scintillation counter. Triple coincidences gated a multi-channel analyzer which recorded the pulse height spectrum of the protons stopped in the scintillation counter. This pulse-height spectrum was then converted into an energy spectrum of the neutrons incident on the radiator. The neutron spectrum obtained is a continuum with energies from 0–12 Mev. The high-energy end shows a broad group with a peak at 11.3 Mev about twice as high as the flat continuum at intermediate energies. This group can be ascribed to $T(t,n)He^4$. No narrow group at lower energies is observed. Below 4 Mev the spectrum rises again as would be expected qualitatively from the breakup of He^5 into He^4+n. Some of the intermediate energy neutrons may be the result of a very broad excited state of He^8 or three-body breakup or both.

J4. Proton-Alpha Scattering at Medium Energies.* P. D. Miller, G. C. Phillips, R. R. Henry, and J. Erdwin, *The Rice Institute.*—The experimental results of Freier, Lampi, Sleator, and Williams[1] have been checked with excellent agreement at 2.22 Mev and with moderate agreement at 3.58 Mev. The data have been extended to 5.8 Mev using The Rice Institute 5.5-Mev Van de Graaff generator and a gas-scattering chamber. An angular distribution was taken at 5 Mev, and excitation curves were run at the following center-of-mass angles: 39°14′, 54°44′, 70°7½′, 167°28′, 149°26½′, 90°, and 125°16′. The excitation curves are very flat above 3.0 Mev. A phase shift analysis is in progress.

* Supported in part by the U. S. Atomic Energy Commission.
[1] Freier, Lampi, Sleator, and Williams, Phys. Rev. **75**, 1345 (1949).

J5. Angular Distribution and Excitation Function of Neutrons from $N^{14}(d,n)O^{15}$.* Richard W. Johnston and Norman A. Bostrom, *University of Texas.*—The angular distribution of the neutrons resulting from the $N^{14}(d,n)O^{15}$ reaction has been measured for several different deuteron energies ranging from approximately 1.2 to 2.1 Mev. The angular range covered was from 0° to 125° with a 5° angular increment. Nitrogen gas targets were used for all measurements. The neutrons were detected by a sphere-type[1] scintillation detector which was biased so that only the ground-state neutron group was detected. The energy sensitivity of the counter was determined by measuring the field from the d-d reaction, the cross section for which is well known. The excitation function for the $N^{14}(d,n)O^{15}$ reaction was measured at 0° and at 90° for deuteron energies ranging from approximately 0.6 to 2.4 Mev.

* Assisted by the U. S. Atomic Energy Commission.
[1] McCrary, Taylor, and Bonner, Phys. Rev. **94**, 808(A) (1954).

J6. Energy Levels in O^{16}, F^{19}, and Cu^{65}.* T. E. Young, G. C. Phillips, and R. R. Spencer, *The Rice Institute.*—The $F^{19}(p,\alpha)O^{16}$, $F^{19}(p,p')F^{19}$, and $Cu^{65}(p,p')Cu^{65}$ reactions have been studied using bombarding energies of approximately 5 Mev. Reaction products were analyzed at 180° to the incident beam with an annular magnetic spectrometer. Alpha-particle groups were observed corresponding to Q values of 2.061 ± 0.015, 1.981 ± 0.0008, 1.193 ± 0.008, 0.997 ± 0.008, and -0.763 ± 0.008 Mev for the $F^{19}(p,\alpha)O^{16}$ reaction. Energy levels were confirmed at excitation energies of 1.344 ± 0.005, 1.458 ± 0.005, and 1.554 ± 0.005 Mev in F^{19}. Excited states were observed at 0.768 ± 0.004, 1.112 ± 0.004, and 1.622 ± 0.005 Mev in Cu^{65}. The targets used for the study of copper were enriched to 98.16% in Cu^{65}. Comparison of these states with the first three excited states[1] in Cu^{63} shows the similarity expected on the basis of the shell theory. Approximate differential cross sections have been obtained for the reactions studied.

* Supported in part by the U. S. Atomic Energy Commission.
[1] Windham, Gossett, Phillips, and Schiffer, Phys. Rev. **103**, 1321 (1956).

J7. $Na^{22}(n,p)Ne^{22}$ Excitation Curve in the Energy Interval 3.3 to 6.0 Mev.* N. A. Bostrom,† R. G. Moore,‡ and I. L. Morgan,† *University of Texas.*—The absolute cross section has been measured for the $Na^{23}(n,p)Ne^{23}$ reaction for incident neutrons of energies 3.3 to 6.0 Mev. A NaI(Tl) crystal was bombarded by monoenergetic neutrons from the d-d reaction, and the resulting 40.7-sec activity from Ne^{23} was observed. Resonances in the excitation curve indicate excited levels in Na^{24} at 11.93 and 12.33 Mev. The cross section rises from essentially zero below $E_n=4.3$ Mev (calculated threshold $=3.59$ Mev) to a value of 10 mb at $E_n=6.0$ Mev. The estimated error in the cross-section values is ±30%.

* Assisted by the U. S. Atomic Energy Commission.
† Now with Texas Nuclear Corporation.
‡ Now with Convair.

J8. Inelastic Scattering of Neutrons from Copper.* J. T. Prud'homme and Ira L. Morgan, *University of Texas.*—The de-excitation γ-ray yields were used to determine the

cross section for the neutron excitation of the 660-kev level in Cu^{63} in the energy range from 600 to 1100 kev. Neutrons were produced by the $Li^7(p,n)Be^7$ reaction by bombardment of a 15-kev lithium target. The γ-ray yields were measured with a single crystal scintillation spectrometer. The neutron flux was measured with a calibrated BF_3 counter. Scattering samples consisted of copper rings, and a C−H ring was used for background subtraction. Several well-resolved resonances in the excitation curve were observed at $E_n = 800$, 830, 880, 940, and 1024 kev. The differential inelastic cross sections at 100° ranged from 0.82 mb/sterad at 750 kev to 7.2 mb/sterad at 1050 kev. The experimental error on the cross sections is estimated at ±15%, and the incident energy spread was 20 kev. Theoretical curves calculated from the Hauser-Feshbach formula, using a spin transition $\frac{3}{2}^-$ to $\frac{5}{2}^-$ and nuclear penetrabilities determined from the "cloudy crystal ball" theory, gave values which were higher than the experimental values. Regardless of the spin transition assumed, a theoretical fit to the experimental data would require an absorption parameter in the complex potential of less than 0.1.

* Assisted by the U. S. Atomic Energy Commission.

J9. Inelastic Scattering of Protons from Nickel.* R. R. SPENCER, G. C. PHILLIPS, AND T. E. YOUNG, *The Rice Institute.*—Separated isotopes of Ni^{58} and Ni^{62} were evaporated onto thin foils and bombarded with protons from The Rice Institute 5.5-Mev Van de Graaff accelerator. Thin foils of natural nickel were also bombarded. The region of excitation 0–3.09 Mev in nickel was studied by analyzing the inelastically scattered protons with a 180° magnetic spectrometer. States were observed corresponding to excitation energies of 2.456±0.007, 2.491±0.007, 2.779±0.004, 2.905±0.004, 2.945 ±0.005, and 3.041±0.004 Mev in Ni^{58}; protons from states at 1.171±0.004, 2.047±0.004, and 2.304±0.005 Mev in Ni^{62} were observed. Additional proton groups from the natural nickel targets were observed and were presumed to be from states at 2.161±0.005, 2.286±0.004, and 2.628±0.006 in Ni^{60}. It is interesting to compare the first excited states of Ni^{58}, Ni^{60}, and Ni^{62} at 1.45,[1] 1.33,[1] and 1.17 Mev, respectively, where the repeated addition of two neutrons to the closed proton shell decreases the energy of excitation of the lowest state by about the same amount in both cases.

* Supported in part by the U. S. Atomic Energy Commission.

[1] Windham, Gossett, Phillips, and Schiffer, Phys. Rev. **103**, 1321 (1956).

Invited Papers

J10. Neutron Multiplicities from Fission. JAMES TERRELL, *Los Alamos Scientific Laboratory.* (30 min.)

J11. Meson Production at Very High Energies. M. W. TEUCHER, *University of Oklahoma.* (30 min.)

SATURDAY MORNING AT 9:30

Research Institute Physics, Room 213

(H. D. SMYTH presiding)

Invited Papers

K1. The Development of the History of Science in America. D. H. D. ROLLER, *University of Oklahoma.* (30 min.)

K2. The Development of Electricity in Thunderstorms. E. J. WORKMAN, *New Mexico Institute of Mining and Technology.* (30 min.)

K3. Atmospheric Ozone. V. H. REGENER, *University of New Mexico.* (30 min.)

K4. The Melting Process at Low Temperatures and High Pressures. E. R. GRILLY, *Los Alamos Scientific Laboratory.* (30 min.)

SATURDAY MORNING AT 9:30

Meacham Auditorium

(WILLIAM SCHRIEVER presiding)

Invited Papers in Geophysics

M1. The Propagation of Transient Elastic Disturbances in Solid Bodies. N. H. RICKER, *Carter Oil Company.* (30 min.)

M2. A Theoretician's Observations on the Role of Elastic Wave Propagation in Geophysical Exploration. ELLIS STRICK, *Shell Development Company, Houston.* (30 min.)

M3. Modern Techniques of Exploration Geophysics. W. M. RUST, JR., *Humble Oil and Refining Company.* (30 min.)

M4. Geophysical Exploration for Ground Water. VICTOR VACQUIER, *New Mexico Institute of Mining and Technology.* (30 min.)

SATURDAY AFTERNOON AT 1:30

Meacham Auditorium

(N. H. RICKER presiding)

Invited Papers in Geophysics

N1. Gravity Prospecting. RAOUL VAJK, *Standard Oil Company of New Jersey.* (30 min.)

N2. Some Magnetic and Electrical Methods of Geophysical Exploration. IRWIN ROMAN, *U. S. Geological Survey.* (30 min.)

SATURDAY AFTERNOON AT 1:30

Research Institute Physics, Room 213

(J. G. POTTER presiding)

Electron Physics

P1. Drift Velocity of Ions in Nitrogen at Low Temperature.* F. R. KOVAR, R. N. VARNEY, AND E. C. BEATY, *Washington University.*—The drift velocity of ions in nitrogen, plotted semilogarithmically as a function of E/p_0, the ratio of field strength to normal gas pressure, has been reported previously for gases at room temperature.[1] The result was interpreted to indicate that a heavy ion, N_4^+, was the stable ion at low E/p_0 but that its binding energy was small enough that it either failed to form or dissociated to give an N_2^+ ion at higher E/p_0. To test the interpretation, the same experiment now has been performed with the tube cooled to 77.4°K, the assumption being that at the low temperature there would be appreciably less likelihood of dissociating the heavy ion by thermal collisions and hence that the N_4^+ ion would be found at higher E/p_0 values. This conjecture is confirmed in the present experiments and thus adds weight to the belief that N_4^+ is the normal, stable ion in much of the atmospheric pressure work done in the past.

* This work was supported by the Office of Scientific Research of the U. S. Air Force and by a grant from Research Corporation.
[1] R. N. Varney, Phys. Rev. **89**, 708 (1953).

P2. Equivalent Resistance of a Low-Pressure Spark Discharge Column.* R. G. FOWLER, *University of Oklahoma.*—Simple empirical relations have been observed between the potential difference across an intense low-pressure spark discharge and the current through it when the discharge is produced by delivering the energy of a charged capacitor to the gas. The relations are common in form for all gases studied so far, at all pressures and discharge energies. The empirical relation can be derived under the assumption that electron temperature reaches a nonequilibrium saturation value during the ionization process. Predictions made from the relation have been verified, and it seems likely that the relation will assist in the design of electric driven shock tubes.

* Supported by the Office of Naval Research.

P3. Magnetic Measurements of the Resistivity of a Flowing Plasma.* M. SAKUNTALA, *University of Oklahoma* (introduced by R. G. Fowler).—Experiments of Clotfelter[1] on the expanding plasma from an electrically driven shock tube showed that electromagnetic induction in a magnetic field could be used to measure flow velocities but gave anomalous results for the internal resistance of the plasma. Recent experiments have clarified this point, showing that various solid materials show unexpected short-circuiting action caused by induced conductivity when exposed to the ionized gas. Evidence now shows that the resistivity is associated primarily with heavy ion mobility and that ion concentration probably can be deduced from the measurements. If the latter is true, the ion concentrations indicated by first-order Stark broadening in the same situation are in serious error and suggest the need for a temperature correction.

* Supported by the National Science Foundation.
[1] B. E. Clotfelter and R. G. Fowler, Phys. Rev. **91**, 436(A) (1953).

P4. On the He I Forbidden Transition (4^3f-2^3p).* G. E. SEAY AND L. B. SEELY, JR., *Los Alamos Scientific Laboratory.*—The He I forbidden transition (4^3f-2^3p) is observed unshifted in stellar atmospheres, but, when produced in a homogeneous electric field, it is always shifted toward the blue.[1] The authors recently have observed this line with helium at a kinetic temperature of about 20 000°K and ion densities of 10^{17} to 10^{18} cm^{-3}. These conditions were produced by means of an explosive-driven shock tube.[2] Observed shifts to the blue are predictable when a homogeneous field is assumed which has a strength and probability distribution as given by Holtzmark.[3,4] It has been proposed that the absence of shift in stellar atmospheres is the result of the nonhomogeneity of the field,[1] but the theory which considers this effect, when applied to conditions found in the explosive shock tube, predicts shifts of an order of magnitude larger than those observed.

* Work performed under the auspices of the U. S. Atomic Energy Commission.
[1] M. K. Krogdahl, Ap. J. **102**, 64 (1945).
[2] G. E. Seay and L. B. Seely, Jr., Bull. Am. Phys. Soc. Ser. II, **1**, 227 (1956).
[3] J. S. Foster, Proc. Roy. Soc. (London) **A117**, 137 (1927).
[4] J. Holtzmark, Ann. Physik **58**, 577 (1919).

P5. Analysis of Activation Overpotential into Exponentially Decaying Components. L. WHIT MARKS AND WILLIAM SCHRIEVER, *The University of Oklahoma.*—The cathode overpotential, measured after electrolysis ceased, was found to decay rapidly during the first few minutes and then relatively very slowly. Each of these decays was expressed as the sum of three exponentially decaying components which disappeared, respectively, in approximately 2.5, 11, and 20 or more minutes. These three components, observed in HCl with Pt electrodes and with several other electrode-electrolyte systems, were interpreted to be components of hydrogen (activation) overpotential. These components were associated with adsorbed

layers (states) of the hydronium ion, H_3O^+, and two distinct adsorbed states of the hydrogen ion, H^+ and $^*H^+$. The most rapidly decaying component was interpreted to be the transfer of the H_3O^+ adion to the H^+ adion; the second component was the transfer of the H^+ adion to the $^*H^+$ adion, another adion state; and the most slowly decaying component was interpreted to be the transfer of the $^*H^+$ adion to the adsorbed H atom. This adatom layer produced no measurable potential except in higher concentrations of HCl, where a fourth extremely slowly decaying process was observed.

Post-Deadline Papers, If Any

SUPPLEMENTARY PROGRAMME

SP1. Intensities of "Inactive" Infrared Bands in Liquid Solutions. ELDON E. FERGUSON, *U. S. Naval Research Laboratory.**—The intensities of the so-called "inactive" infrared absorption bands in liquid solutions have been found to be a rather sensitive measure of intermolecular interaction in solutions. The intensities show a strong correlation with the intermolecular dispersion forces between solvent and solute molecules and some correlation with surface tension and other liquid parameters. The strongest inactive vibration bands of benzene are enhanced in intensity by methylene bromide, pyridine, chlorobenzene, bromobenzene, carbon disulfide, and methylene iodide, the enhancement increasing in that order. The bands are diminished in intensity by N decane, methylene chloride, carbon tetrachloride, and cyclohexane. This ordering arrangement is demonstrated to have a remarkable degree of internal consistency, i.e., the same ordering is obtained by measuring inactive fundamental intensities of other compounds. Some measurements of half-widths and integrated extinction coefficients also will be presented for several cases where such measurements have been obtained.

* To be given at the end of Session F if the Chairman rules that time permits.

SP2. Kinks Are Inherent Property of Matter in the Liquid State. GEORGE ANTONOFF, *33 Tier Street, New York 64, New York.**—Lately it has become fashionable to attribute the *kinks* to experimental errors which have arisen as a result of *smoothing* of the results. This habit, although objectionable, generally lessens the actual kinks but on the whole gives the correct picture, and the kinks observed can be attributed only to the inherent properties of matter. My attention was directed to this fact by Professor Carl Benedicks, Member of the Swedish Royal Academy, who recommended a method for verifying the existence of kinks. I communicated it to Scientific and Industrial Research in Karachi, Pakistan, where they used it in a modified form and find kinks everywhere where they should be. Lately I used paper RP523 of the National Bureau of Standards which gives values for *vapor pressures*, and the paper by Smith *et al.*[1] Taking the average of several experiments, I obtained the same results. This convinced me once more that we deal here with an important *law of nature*.

* To be given at the end of Session E if the Chairman rules that time permits.

[1] Smith, Keyes, and Gerry, Proc. Am. Acad. Arts Sci. **69**, 137 (1934).

Author Index to Papers Presented at the 1957 Southwestern Meeting in Norman, Oklahoma

Antonoff, George—E11, SP2
Babb, S. E., Jr.—C8
Baird, James C.—C6
Bame, S. J., Jr.—J3
Beaty, E. C.—P1
Beer, A. C.—A3
Bird, George R.—C6
Bleil, C. E.—A1
Bostrom, Norman A.—J5, J7
Bunker, M. E.—J2
Burgers, J. M.—G1
Carrier, G. F.—G4
Collins, R. L.—F6
Coon, J. B.—C7
Dempsey, C. W.—F2
Erdwin, J.—J4
Ferguson, Eldon E.—C9, SP1
Fink, R. W.—J1
Fowler, R. G.—P2
Grilly, E. R.—K4
Halley, C. J.—C5
Harris, Forest K.—E6
Helmer, R. J.—E2
Hemmendinger, A.—E2
Henry, R. R.—J4
Hijikata, Katsunori—C3
Howard, R. A.—E3
Hudspeth, Emmett L.—E4
Hurst, R.—C2
Jammer, Max—B5
Johnston, Richard W.—j5
Jones, J. T., Jr.—B4
Jones, V. L.—E7
Kendall, G. L.—A3
Kern, E. L.—A8
Kies, Joseph A.—A7
Kovar, F. R.—P1
Leland, Wallace T.—J3
Levinger, J. S.—B3
Liehr, A. D.—B1
Low, Frank J.—F5
Loyd, C. M.—C7
Marks, L. Whit—P5
Matsen, F. A.—B6, C2
Miller, J.—C2
Miller, P. D.—J4
Mize, J. P.—J2
Moore, R. G.—J7
Morgan, Ira L.—J7, J8
Moss, T. A.—B3
Musa, R. S.—E10
Narasimham, N. A.—C5
Nielsen, J. Rud—C1, C4, C5
Nolle, A. W.—F7
Oliphint, Clark—A6
Osborne, W. Z.—E3
Park, M. K.—A8
Parr, J. O., Jr.—E8
Phelps, Francis P.—F3
Phillips, G. C.—J4, J6, J9
Platas, O.—C2
Plint, C. A.—A4, C5
Prud'Homme, J. T.—J8
Rastrup-Andersen, John—C6
Regener, V. H.—K3
Richardson, J. T.—F2
Rickard, J. A.—E5
Ricker, N. H.—M1
Roller, D. H. D.—K1
Robertson, W. W.—C8
Roman, Irwin—N2
Romberg, F. A.—F1
Rorschach, H. E.—F1
Rosa, Richard—G2
Rust, W. M., Jr.—M3
Sakuntala, M.—P3
Salter, L.—E9
Sapp, R. C.—F2
Scales, William W.—A2
Schaaf, S. A.—G3
Schriever, William—P5
Seay, G. E.—P4
Seely, L. B., Jr.—P4
Skinner, Selby M.—A8
Smith, George W.—F4
Smith, Herschel L.—A7
Spencer, R. R.—J6, J9
Squire, C. F.—F2, F4, F5
Starner, J. W.—J2
Strick, Ellis—M2
Teal, G. K.—E1
Terrell, James—J10
Teucher, M. W.—J11
Theimer, Otto—A5, A9
Theimer, Rose—C4
Trivisonno, N. M.—A8
Vacquier, Victor—M4
Vajk, Raoul—N1
Valk, H. S.—B2
Varney, R. N.—P1
Ward, J. K.—C7
Willardson, R. K.—A3
Williamson, Claude F.—E4
Workman, E. J.—K2
Young, T. E.—J6, J9
Zimmerman, J. R., Jr.—F8

Second Announcement of the 1957 Philadelphia Meeting

In 1957, and probably for the first time in our history, we shall hold two meetings in the month of March. The earlier of these is the one to which this issue of the Bulletin is devoted: it was announced in the Monterey Bulletin of last December. The other will be the usual "March meeting" at which our Divisions of High-Polymer Physics and Solid-State Physics figure so largely. The dates are March 21, 22, and 23; the city is Philadelphia; the scientific sessions will be at the University of Pennsylvania, and the headquarters hotel is the Benjamin Franklin. The rates are $7 to $11 per day for singles, $10 to $14 for doubles, and $14 to $16 for twin-bed rooms.

Preliminary Announcement of the 1957 Spring Meeting

The 1957 Spring Meeting of the American Physical Society will be held in Washington, D. C., at the Sheraton-Park and Shoreham Hotels and the National Bureau of Standards, on Thursday, Friday, and Saturday, April 25, 26, and 27. Room reservations are to be made by writing to the Sheraton-Park Hotel, Washington 8, D. C., and specifying that the writer is a member of the Society. The Sheraton-Park undertakes to provide rooms in other hotels after its own allotment to our members is fully booked: our members may designate the hotels of their choice. Deadline will be Friday, February 15, 1957. Abstracts for this meeting must be received not later than this date at the office of the American Physical Society, Columbia University, New York 27, New York.

MEETINGS AND DEADLINES FOR THE SEASON 1956–1957

Place	*Meeting dates*	*Deadline date*
New York	January 30–February 2	past
Norman, Oklahoma	March 1–2	past
Philadelphia	March 21–23	past
Washington, D. C.	April 25–27	February 15
Notre Dame, Indiana	June 20–22	April 12
Boulder,* Colorado	September 5–7	July 8

* Abstracts for the Boulder meeting are to be sent to W. A. NIERENBERG, University of California, Berkeley 4, California, and must reach his office not later than the corresponding deadline date.

Abstracts for the other meetings listed above are to be sent to KARL K. DARROW, American Physical Society, Columbia University, New York 27, New York, and must reach his office not later than the corresponding deadline date. Take note that abstracts mailed the day before deadline-day often fail to arrive in time: the last postal delivery of the day usually comes to our office before 2 P.M. Allow at least two days for abstracts sent by airmail from points east of the Mississippi, and longer for those sent from farther west. To avoid chance of confusion, please do not send an abstract for any meeting until the deadline date of the previous meeting is at least five days past. *The privilege of contributing papers to meetings of the American Physical Society is restricted to the members of the Society and to nonmembers whose papers are sponsored by members.*

RULES PRESCRIBED FOR ABSTRACTS

The Council has ordered that abstracts shall be not longer than two hundred (200) words or the equivalent thereof. In reckoning equivalence, a footnote is equated to ten words; each line in a table to ten words; a "display" formula—one that requires a line to itself—is an expensive luxury equated to forty words.

Two copies of each abstract must be sent to the appropriate office. They must be typewritten and double-spaced; one must be an original, the other may be an original or a carbon copy. Each abstract must be confined to a single page: if it is too long for a single page it is too long to be printed. *Henceforth, if we receive an abstract typed on two pages, we shall print only its first page.* Write each abstract as a single paragraph: the suppression of paragraphs costs time and labor to the editors. Do not use very thin paper; a sheet of very thin paper may cause extraordinary trouble when mixed with sheets of reasonable thickness. Look at the abstracts in this *Bulletin* to see how the title of the paper and the name of the author are to be arranged, and follow the example. Issues of the *Bulletin* are sometimes appreciably delayed because the editors have to do what the authors should have done.

Remember the rule of the Council that, if an author submits more than one abstract, all but one must go onto the Supplementary Programme. In enforcing this rule, an abstract is credited to the author whose name appears first in the by-line. **By action of our Council, abstracts will not henceforth be withdrawn from our proofs unless the asker sends ten dollars with his request.**

The American Physical Society

OFFICERS OF THE SOCIETY FOR 1956

President	E. P. WIGNER	Princeton University
Vice-President	H. D. SMYTH	Princeton University
Secretary	K. K. DARROW	Bell Telephone Laboratories (*retired*) (Office at Columbia University)
Treasurer	G. B. PEGRAM	Columbia University
Managing Editor	S. A. GOUDSMIT	Brookhaven National Laboratory
Local Secretary for the Pacific Coast	W. A. NIERENBERG	University of California, Berkeley

Past Presidents now on Council: W. F. G. Swann, H. A. Bethe, and R. T. Birge.

Elected Members of the Council: L. I. Schiff, W. Shockley, John Bardeen, A. O. Nier, F. Seitz, A. M. Weinberg, S. K. Allison, and N. F. Ramsey.

Please cut along this line

(**To be sent to Professor J. Rud Nielsen, University of Oklahoma, Norman, Oklahoma**)

I EXPECT to attend the dinner of the American Physical Society at seven o'clock on Friday evening, March first. My party will comprise . . . persons.

(*Name*) . . . . . .

(*Address*) . . . . . .

(If you want your tickets held to the time of the banquet itself, send a check, made out to American Physical Society, for $3.00 per plate.)